

## Power of Partnerships: Accelerating the Clean Energy Economy

In this video, Bill Becker of the Clean Energy Solutions Center interviews former National Renewable Energy Laboratory director Dr. Dan Arvizu about some lessons learned during his tenure that could be applicable to other countries, what the future of clean energy may look like, and how partnerships can accelerate the clean energy economy.

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### Bill Becker

This is Bill Becker for the Clean Energy Solutions Center at the National Renewable Energy Laboratory here in the United States. Dr. Dan Arvizu has been the laboratory director here at NREL for the last ten years, a very distinguished tenure. Before that he was the chief technology officer at one of the world's leading environmental engineering companies before that, Sandia Laboratories. He has very unusual and rich perspectives on the development of new technologies. Sadly in March of 2015 he announced that he was retiring from this laboratory and moving on to other things but he agreed to sit down and spend some time with us to talk a little bit about what he's done and what he's learned over these years. So here's Dr. Arvizu.

Dr. Arvizu, one of the things you've accomplished in these ten years at the National Renewable Energy Laboratory is to increase public/private partnerships, these research arrangements with the private sector to sort of increase the laboratories and the company's power on technology. Are the lessons that you've learned here that other countries especially developing countries can take advantage of?

### Dan Arvizu

Well thank you for the question. I think partnership is kind of one of the watch words that we have here at the National Renewable Energy Lab. Specifically what I like about partnerships is it is really quite a powerful tool. It does a number of things that I think are a benefit to both parties. So the first thing it really does for the research community and those of us in the laboratory who are looking to apply our talents in some meaningful, impactful sort of way is to really get a bead on what the gaps are in the marketplace.

So it gives us that market understanding. I think that's a really important piece of making sure we guide the research in a very, very positive and efficient way. From the side of the private sector partner whether they be an industry

partner or a government industry or some other research performer what we do get is the opportunity to have them also leverage their resources in a way that helps them accomplish their goals much more efficiently, much more effectively in a quicker timeframe.

**Bill Becker**

Do you think there's some lessons there for developing economies? Do they have the potential also for these public/private partnerships?

**Dan Arvizu**

Yes. I think the tool and the mechanism is actually universally applicable I mean no matter where you are. Typically in a domestic kind of environment that we live in the U.S. we're kind of primarily focused on research in our laboratory. I think when you get to developing countries you're focused on applications. You're focused on the implementation. Sometimes that takes a little creativity on how to take technology maybe that's kind of ready for commercial application but not yet ubiquitous and not yet fully understood by a lot of players. So it gives that opportunity to really hold each other in a way in which you can really take advantage of the strengths that you each have.

**Bill Becker**

To be more specific about some of your achievements here I understand that one of the areas you've explored is energy systems integration.

**Dan Arvizu**

Oh yes.

**Bill Becker**

I wondered if you'd tell us what that is.

**Dan Arvizu**

Well it's caught on quite nicely over the last five or so years. Energy systems integration is really nothing more than looking more holistically at the solution end of how you use energy. So in if you think about electricity we've had a system that had one-way power flow. We had big central power stations generating electricity and then you put them on big wires and subsequent smaller wires and ultimately it gets to the end user who gets to use the electrons coming out on the wall socket, let's say. That's kind of a one-way power flow and something that I think has been the way in which we've considered energy.

If you take a step back and you say, "I'm not just caring so much about the electrons that are coming out of the wall socket but more importantly thinking about the energy services that the electricity provides," then you can think about how you might use electricity maybe more efficiently, how you might use electricity in a way that provides you with more benefit. If you take that systems perspective you begin to then think about not just the energy services but how you generate energy, how you use energy and you think about it as a system. All of a sudden you may at the end point may have put a solar rooftop panel on your home or your business and generate a little bit of electricity. Now I need electricity that's got two-way power flow.

Now I'm thinking about my energy system very differently than I did before. Now if you take that concept in electricity and then expand it even further to other infrastructures there's not just electricity. There's thermal energy for heat and a variety of other things that you might use thermal energy for comfort. Then you add to that maybe a water infrastructure of some other mobility infrastructure. Now you begin to think about all of those

infrastructures working in harmony together. If you look at it from that perspective and, again, the service that you're trying to extract from these infrastructures then you begin to optimize in a different way than you would if you just thought about electricity as electrons flowing from the power station to your device.

**Bill Becker**

A whole different perspective.

**Dan Arvizu**

It provides you with a much more what we call a systems look and it allows you to optimize and actually improve the inefficiencies that are inherent in those infrastructures if you think about them one at a time and not holistically.

**Bill Becker**

You mentioned water and I'd like to pursue that a little bit. There's a lot of more attention these days to what's being called the energy water nexus, the fact that it takes energy to move water. It takes water to produce energy. How important a factor do you think that will be in the decades ahead?

**Dan Arvizu**

Well again, one of the ideas behind the energy systems integration is to be able to remove the inefficiencies in those systems. So it turns out that water is incredibly important not just domestically and as we've now learned in the past few years about the droughts that we're having out West domestically. It makes everyone's attention to water and water usage much more intense. No matter where you go in the world you have those same dynamics in play. So it's now come time that we now look at how we generate energy and do it in as efficient a water usage mode as we can.

Likewise, moving water is—typically takes a lot of energy. How do we do that more effectively? So looking at how these two systems interact with one another I think is one of the next big things that I think not just this country but most economies on the globe are going to be worried about in years to come especially in areas where fresh water is limited, energy is limited. Now we have to go to desalination and other ways in which you might create fresh water that is going to require a lot of energy at the same time.

**Bill Becker**

To put a little bit finer on that. Do you think the water availability is going to be a major factor in the choice people make about energy resources and how we produce energy?

**Dan Arvizu**

Yes. Again, back to that systems perspective that I think we need to look at. One of the nice things about purifying water, say desalination where you're taking essentially ocean water and you're creating fresh water out of is that you can actually do that very efficiently when the sun shines and use solar energy input as opposed to using a diesel generator that might be either more energy intensive and obviously environmentally less friendly than you might use with a clean source. So depending on what the load looks like and what the resources look like you can match those energy water usages in ways in the future I think that would allow you to look at that nexus much more, again, in an optimized fashion than what we would traditionally look at without really focusing on the holistic piece.

**Bill Becker**

One of the things I think you're pointing about desalination—it's difficult word for me—is that we need to look at what kind of energy is producing water or producing energy or producing electricity for electric vehicles that some technologies that seem very virtuous on the surface you need to look further perhaps systematically back at how that energy is being produced. Correct?

**Dan Arvizu**

Yes. So I think the point you're making is life cycle analysis is a very important piece of both that sustainability part as well as doing the calculation. So what—it can't just be on how much does it cost. It's got to be, "How much does it cost? How efficient is it? How accessible is it? How robust and reliant and resilient is it? Ultimately, how much environmental impact it might have?" I think all forms of technology have bits and pieces of all of those variables. I think the analysis on how to both generate energy and use energy requires that we look at it from that broadest perspective.

**Bill Becker**

Yeah. It's a much more sophisticated analysis than we've been used to doing in the past I think.

**Dan Arvizu**

Yeah, very much so.

**Bill Becker**

The Clean Energy Solution Center is one mechanism that NREL hosts to provide technical assistance to other countries in terms of national energy policy. Are there other ways that other countries can access the laboratory system, NREL and some of the other laboratories? Are there services that they can tap into?

**Dan Arvizu**

Sure. One of the things that we pride ourselves in is that as we do work and we're sponsored by primarily government funding that that work benefits not just those that are anxious to get an immediate answer but more generally the entire community of stakeholders which includes not just domestic users but developed and developing country users as well. So the analysis that we do all kind of fits into that mode. So the Clean Energy Solutions Center is one of the elements of the Clean Energy Ministerial which is a very important piece of an alliance or collaboration that we have with other countries to help promote the use of both sustainable energy, renewable energy, emission-free type of technologies.

Another piece of that is the 21st Century Power Partnership. In that particular part of the Clean Energy Ministerial initiative we're working with other countries primarily run their power sector and looking at how can we provide both counsel, guidance, policy analysis to help them implement their own level of initiatives around kind of clean energy. So that at the broadest level that's kind of the umbrellas in which we work.

There are a couple of others. We have another initiative called the LEDS which is the low-emissions development strategies initiative which is funded both by the USAID and the Department of State. In both of those cases again we're looking at developing economies and having our expertise, training, capabilities be accessible to countries that are really looking for local economic development, another big area of work that we do here at NREL.

The last piece has to do with our work with private foundations. So we have the Children Investment Fund Foundation, which is a not for profit that I think is based out of the U.K. but essentially their interest is in helping economies around the world promote the use of sustainable energy, clean, renewable energy and energy efficiency. We've got two partnerships that we're kind of presently working on; one in Mexico to help Mexico develop a program regarding how they will transform their energy system and their energy economy.

We have another one more recently that we just stood up with China. We're working directly with the State Grid Corporation which allows us to help them develop tools that will enable them to put more renewable energy onto their grid more rapidly. Very similar to the kinds of issues that we have here domestically as we all gear up toward more distributed generation, more use of solar and wind energy on our grid as well as in the distributed form. There we have some analysis and some capabilities that help us understand what are the effects on the grid and how do we manage them more effectively. So we're working with those countries in those areas as well.

**Bill Becker**

Having followed your work these past ten years I know that NREL publishes an enormous amount of literature on its research and its programs. How do people access that in other countries? How do they get to ~~that~~the written reports of your work?

**Dan Arvizu**

So that's one of the tenants of the Clean Energy Solutions Center is that we have kind of a single point of contact that we can connect both researchers, analysis, tools, capabilities, trainings with those that have a very specific need. There's also a very robust ~~I think~~ set of information resources on our website. So you can go to the website and find all kinds of capabilities there. We're working on a number of others where, again, it's one-stop shopping. So going through our website is a good place to start and then you can get to all these various tools and capabilities that we have. Again, our interest is focused on making these materials as widely applicable and accessed as possible so that we make sure we get the word out and that the folks who need access to that information can get it as readily and as conveniently as possible.

**Bill Becker**

It's just a tremendous resource. So glad it's there. We talked about the water resources. I'd like to ask you to stir up your imagination a little bit here.

**Bill Becker**

We're talking just a few months before nations meet for the 21st time, 21 years of negotiations over a clean energy agreement and a climate agreement to reduce greenhouse gas emissions. That's going to happen three months from now. Imagine for a moment that you're standing in front of this collection of delegates from 197 nations who want to hear what the future is for renewable energy and how the technologies you work on can help them solve the climate problem. What would you say to these folks?

**Dan Arvizu**

Yeah, what an awesome thought. I can—it just gives me chills thinking about that kind of an environment. First of all, I think it's commendable that we have so many countries focused on issues I think that affect us all. So I think

the first thing I would say is it is in our collective interest to work together. I think energy is the life blood of most economies and it's almost one of those rights that we all share and I think we need to be focused on it and making certain that all economies and all peoples of the world have access to energy. It is the way in which we will grow and progress our society.

So the first thing I would say is it's important to work together. The second thing I would say is there are a lot of myths regarding what the new technologies can and cannot do. I think there's still a little bit of an old mindset that we've grown up with an energy system in the—really domestically and in the developed world I'll call it that was focused on a couple of false premises and that was that fossil energy would be abundant and it would be accessible to all and it would essentially be inexhaustible and inexpensive and not necessarily having any kind of impact on the environment. We've now since learned that all of those assumptions that we had literally 100 years ago are no longer accurate.

**Bill Becker**

And for many years since 100 years ago.

**Dan Arvizu**

Yeah. So what we now recognize is our public policy which I think energy should be one of these things that governed by public policy needs to more closely align with the future needs of our energy system, not those assumptions that we had literally a century ago that have served us well for some time but no longer are applicable and that in fact moving forward we actually can have—it's a false tradeoff to suggest that if you're going to go with clean energy somehow you make other kinds of sacrifices.

I think what we've learned in terms of the technology progression, in terms of the applications that many of the countries that are looking at low carbon emissions, low emissions of all kinds of energy have learned and that is that solar and wind and hydro and bio power of all kinds has a place where we can actually sustain our energy needs of the future very efficiently, very effectively using these resources both on a small scale—and that can be done by those who are disadvantaged very quickly—as well as big economies that are looking at central power kinds of things. We should share what we've learned very, very quickly with those who are now building the infrastructure of the future because frankly, we're all in this together. Unless everybody is focused on things that relate to sustainability we're not going to be successful on a global basis. So that's one of these areas where I think it can bring us all together much more so than it divides us. It has all these other attendant benefits which is in fact it's accessible, it's low cost, it's environmentally friendly and I think it is a mechanism by which I think we will find that cooperation, collaboration can be something that we can all benefit from.

**Bill Becker**

Yeah. You're reminding me too that how fast technology's developing and how hard it is for public opinion and public policy to keep up with it. If I can make another plug for the Clean Energy Solutions Center that's why it's there, to help people keep abreast of these things.

**Dan Arvizu**

Absolutely. I think that's really where I think the developed nations who have had the opportunity to make investments both on the research side and now in

the early deployment side and in the market, mechanisms that have helped create a market and bring the cost down. They can now share those lessons learned. We are at a point I believe where we're now in an analogous situation to when we used to have—telecommunications was all landline based and we all had big wires that connected our telecommunication interest and needs.

We're now at a point where we're going wireless and wireless is kind of the new technology that allows us to leapfrog that old infrastructure investment. I think there'll come a time when we can say the same thing about energy. I know energy and telecommunications are not the same and we've understood those differences for some time but we've also built in I think a bias that says, "Well they're so different that we can never do this leapfrog idea." I think we're at a point now where we can actually begin to think about that.

**Bill Becker**

Yeah, I agree. Can I ask you—do you have time for one more imagination question?

**Dan Arvizu**

Yeah, sure.

**Bill Becker**

Because you've been at the forefront of technology development not only here at NREL but your previous career with one of the world's great environmental engineering firms and before that at Sandia National Labs you've had a look that few people have at the technologies that are on the horizon, those that are beginning to show some green shoots out there. So it's 2050 now, a year where most of the world agrees we really have to make or have achieved radical reductions in greenhouse gas emissions. What will our life be like in 2050? What will things look like from an energy perspective?

**Dan Arvizu**

Yeah. Well it's interesting because what I'll say about 2050 is that my grandchildren will be middle-aged.

**Bill Becker**

Oh yeah, mine, too.

**Dan Arvizu**

You know that's not that long away. It sounds like a long ways away but it's not. I think what I am mostly excited about is—I'm kind of a researcher at heart. I started in the solar business literally 40 years ago. I was excited by what we were doing in the laboratory at that point in time. It took a good 30 plus years to see those technologies find their way into the marketplace.

So I've had this really rich opportunity to work in research labs and see the best of the best working on the frontiers of science in all disciplines. One of the things I'm mostly excited about is there no lack of innovation. There is more exciting things going on in the laboratory today than ever before. Our challenge is to not let it or require it to take 30 years to find these technologies in the marketplace. We're at the point now where we're getting close to within 20 or 30 years these technologies will be in the marketplace.

There are some exciting things that relate to material science like nanostructure materials that relate to a variety of new functionality that will do a couple of major things; reduce the inefficiency in an incredibly inefficient energy system that we have of today. I expect a lot higher degree of productivity in our energy system, better capital utilization—so for every

dollar invested the amount of return on that dollar in terms of our capital infrastructure will be much, much better—we'll have a whole new type of scientist and professional engineer who he or she will be doing outstanding work much more quickly than anything we could contemplate. I grew up using a slide rule, not even computers.

**Bill Becker**

I think I started with an abacus myself.

**Dan Arvizu**

We all were in that era. Now we have super computers that do all this incredible work. In the future that super computer capability will be at your fingertips. So I see a much more productive individual and society moving at even a more rapid pace than what we have today. It's an exciting future. I really do hope that some of my grandkids can be in that profession at the time but they certainly will be affected by whatever happens in this arena. I actually have a very optimistic view of the future.

**Bill Becker**

Well it is an exciting future. You have had a great deal to do with that. So Dr. Arvizu, thank you for taking the time. Congratulations on your retirement. Good luck in what you're going to do from here. I hope we can stay in touch.

**Dan Arvizu**

Thank you Bill. Good to be with you. All right, very good.